

# **Minneapolis - St. Paul - A Comparison of Community, Residential, and Personal Exposure**

**Funding Sources: EPA STAR Grants  
GR825241-01-0 and R827928-010**

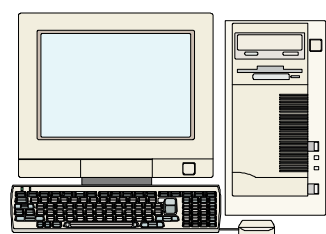
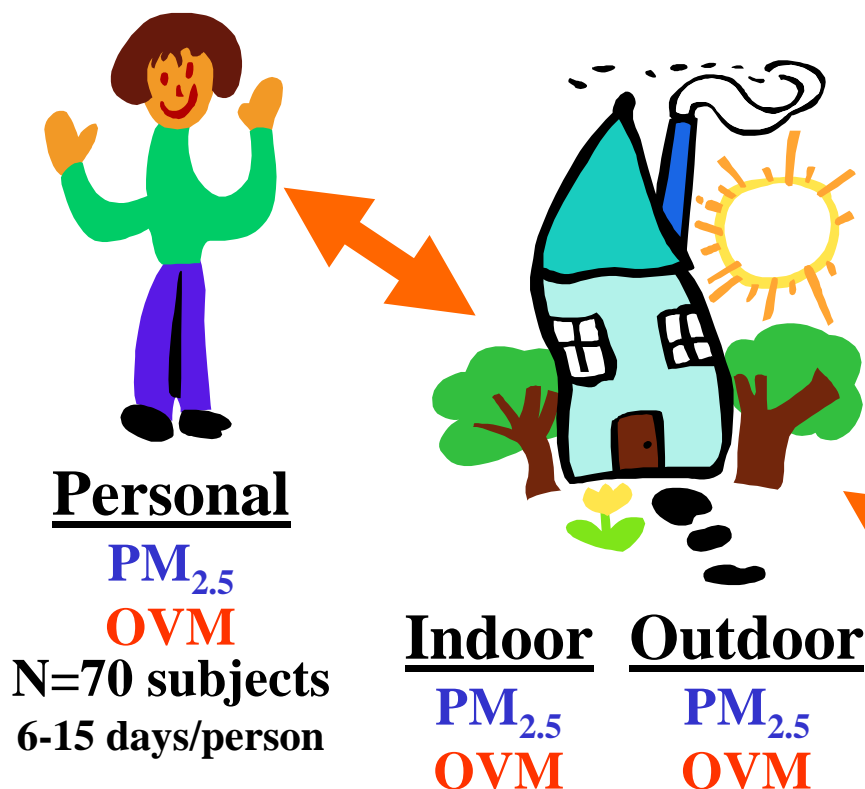
**Gregory C. Pratt, Don Bock, Chun Yi Wu**  
Minnesota Pollution Control Agency, St. Paul

**John Adgate, Ken Sexton,**  
University of Minnesota, Minneapolis  
**Thomas Stock, Maria Morandi**  
University of Texas, Houston

# Outline

- Study design
- Outdoor (O), Indoor (I) and Personal (P) monitoring
- Modeling procedures and results
- Comparing model results OIP monitoring
- Conclusions

**PM<sub>2.5</sub>: 116 24-hour periods**  
**VOCs: 58 48-hour periods**

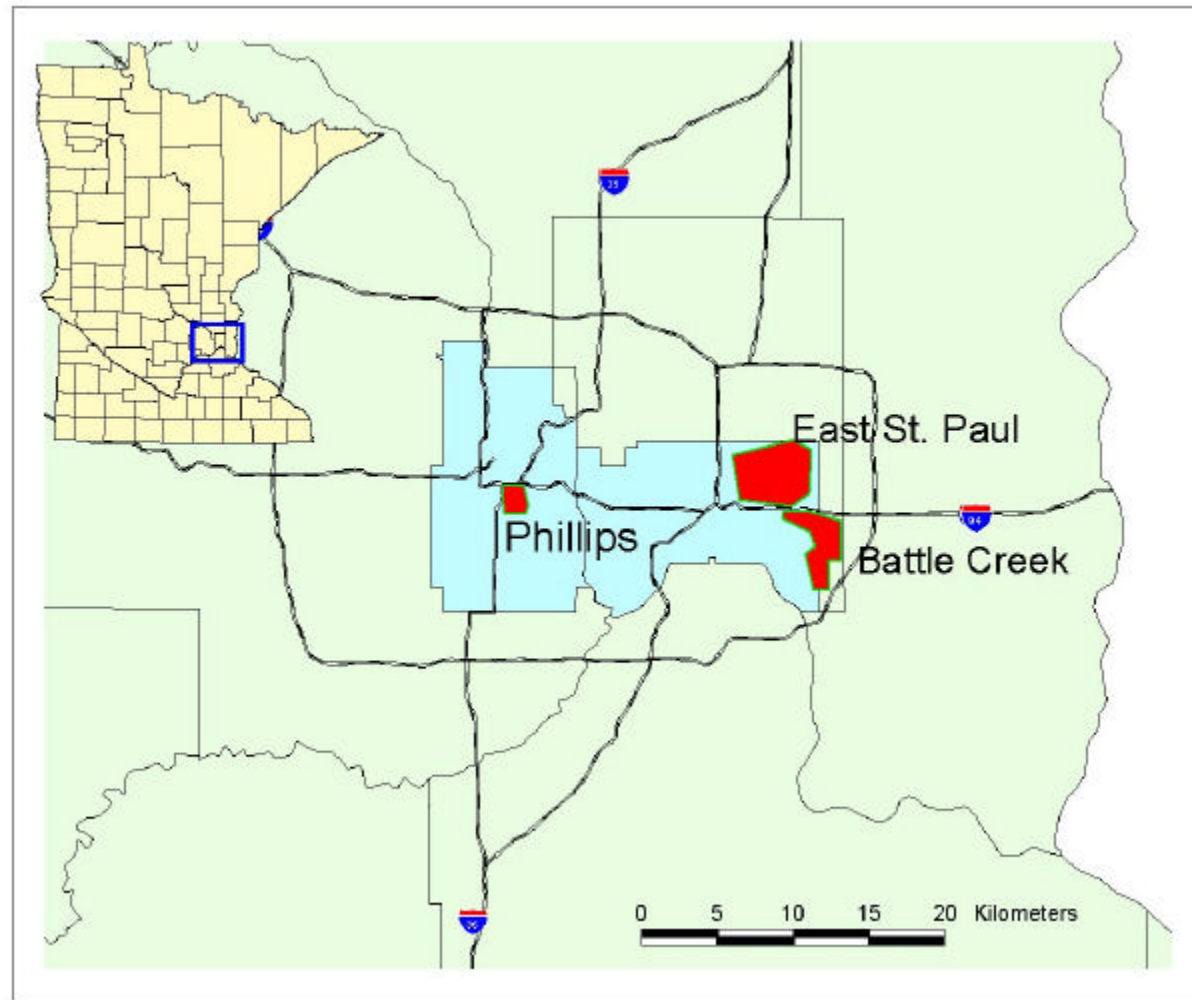


**Modeling**  
**VOCs**

**Neighborhood**  
**PM<sub>2.5</sub> (FRM)**  
**OVM**  
**VOC Canister**  
**N=3**

**Central Site**  
**PM<sub>2.5</sub> (FRM)**  
**VOC Canister**  
**N=2**

# Study Communities

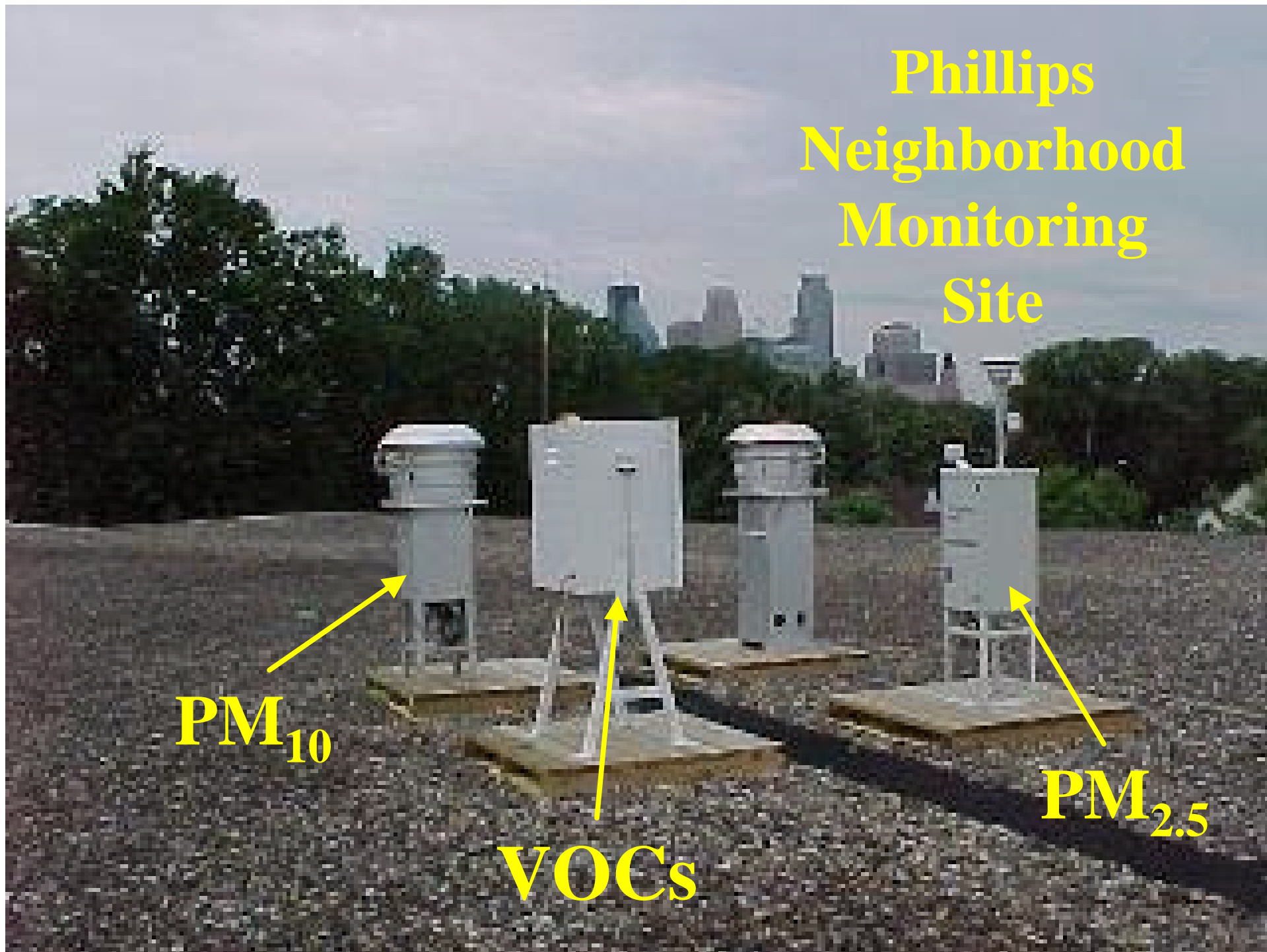


# Phillips Neighborhood Monitoring Site

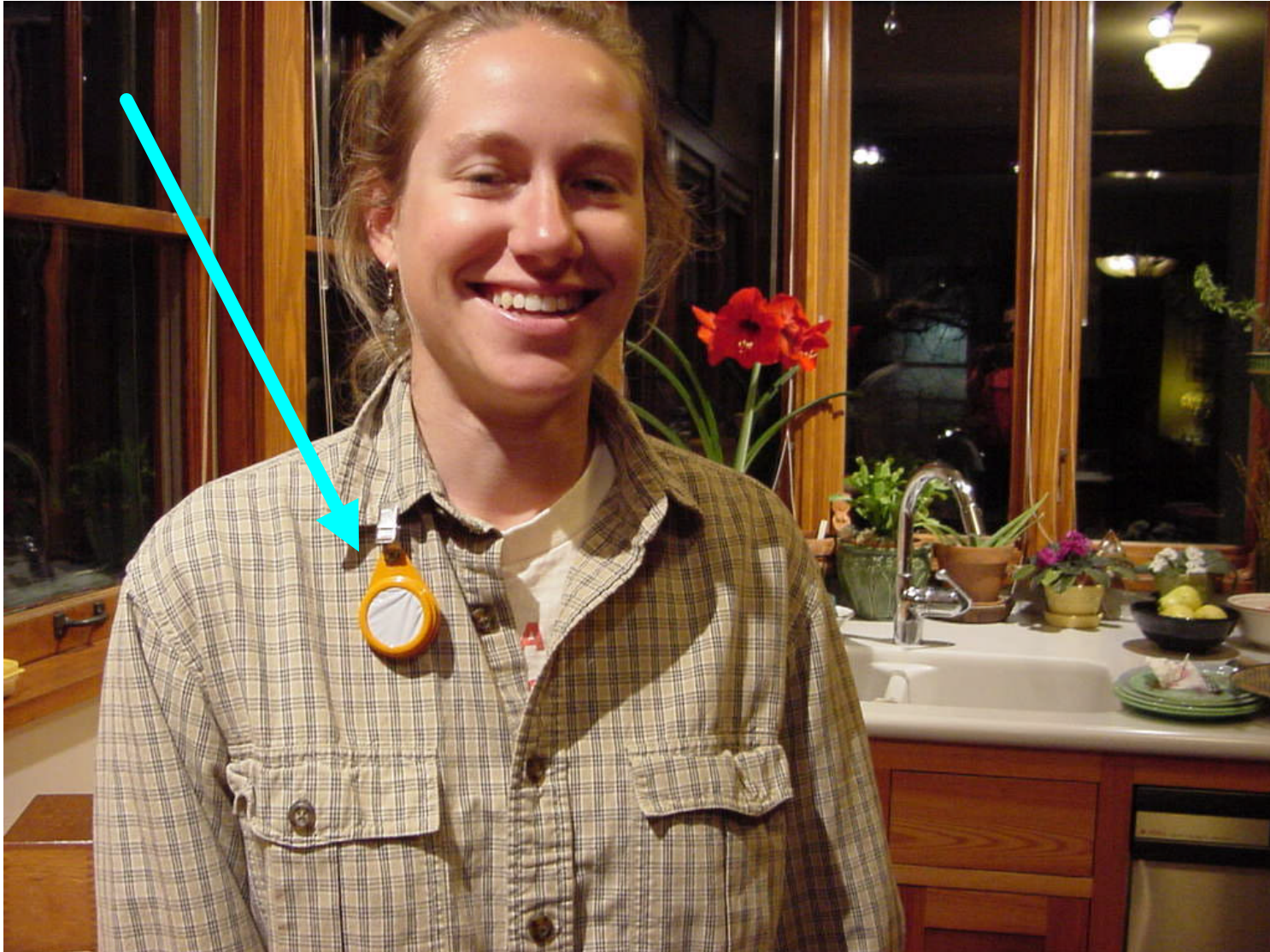
$PM_{10}$

VOCs

$PM_{2.5}$



## 3M Personal Organic Vapor Monitor (OVM)



# VOCs Modeled/Measured

<b>Modeled &amp; Meas. (Badges &amp; FRM)</b>	<b>Modeled (but no badge meas.)</b>	<b>Measurable with Badges</b>
<b>Benzene*</b>	<b>1,3-Butadiene</b>	<b>Carbon tetrachloride</b>
<b>Chloroform</b>	<b>Styrene</b>	<b>a-Pinene</b>
<b>p-Dichlorobenzene</b>	<b>Naphthalene</b>	<b>b-Pinene</b>
<b>Ethylbenzene</b>		<b>d-Limonene</b>
<b>Methylene Chloride</b>		
<b>PERC</b>		
<b>Toluene</b>		
<b>Trichloroethylene</b>		
<b>m,p-Xylene/o-Xylene</b>		



## **Air Dispersion Modeling**

- **Model = ISCST3 version 01001 (EPA regulatory model)**
- **Met data = 1999 MSP airport**
- **Modeled times = 58 48-hour periods corresponding to measurements**
- **Receptors = monitoring sites and participant homes**



## Sources

- **Point Sources** - large stationary sources inventoried individually (424 in metro)
- **Mobile Sources** - cars, trucks, planes, trains, boats, construction equipment, farm equipment, off-road vehicles, lawn and garden equipment, etc. (apportioned to census tracts)
- **Area Sources** - smaller stationary sources inventoried collectively (22 categories apportioned to census tracts)

## **Point Sources**

- **Emissions of 82 pollutants using RAPIDS**
- **Company review of emission estimates**
- **Source locations by GIS address-matching + GPS**
- **Stack parameters averaged over all sources at a facility from (by priority):**
  - 1 DELTA (state permitting system)**
  - 2 Default OTAG values by SCC code**
  - 3 Average OTAG values**

## **Mobile Sources - On-Road and Non-Road**

- **Miles of each road category in each census tract calculated using GIS**
- **MnDOT traffic count data obtained (counts by county and road category)**
- **Used GIS to calculate VMT in census tract**
- **Emission Factors (per VMT) from RAPIDS (based on Mobile 5 model)**
- **Emissions assigned to census tract and modeled as an area source**

## **Mobile Sources - Rail and Air**

- **RAPIDS rail emission were apportioned to census tracts based on the length of rail line in the tract**
- **Airport-related emissions from each airport in RAPIDS were apportioned to the census tract containing the airport**

# Area Source Categories - 1

<b>Agricultural Pesticide Application</b>	<b>Not Done (no VOCs from study)</b>
<b>Architectural Surface Coatings</b>	<b>Population parsing</b>
<b>Asphalt Paving</b>	<b>Not Done (no VOCs from study)</b>
<b>Auto Body Refinishing</b>	<b>Population parsing</b>
<b>Chromium Electroplating</b>	<b>Not Done (no VOCs from study)</b>
<b>Consumer and Commercial Solvent Use</b>	<b>Population parsing</b>
<b>Dry Cleaning</b>	<b>Population parsing</b>
<b>Gasoline Marketing</b>	<b>Population parsing</b>
<b>Graphic Arts</b>	<b>Population parsing</b>
<b>Hospital Sterilizers</b>	<b>Population parsing</b>
<b>Human Cremation</b>	<b>Not Done (no VOCs from study)</b>

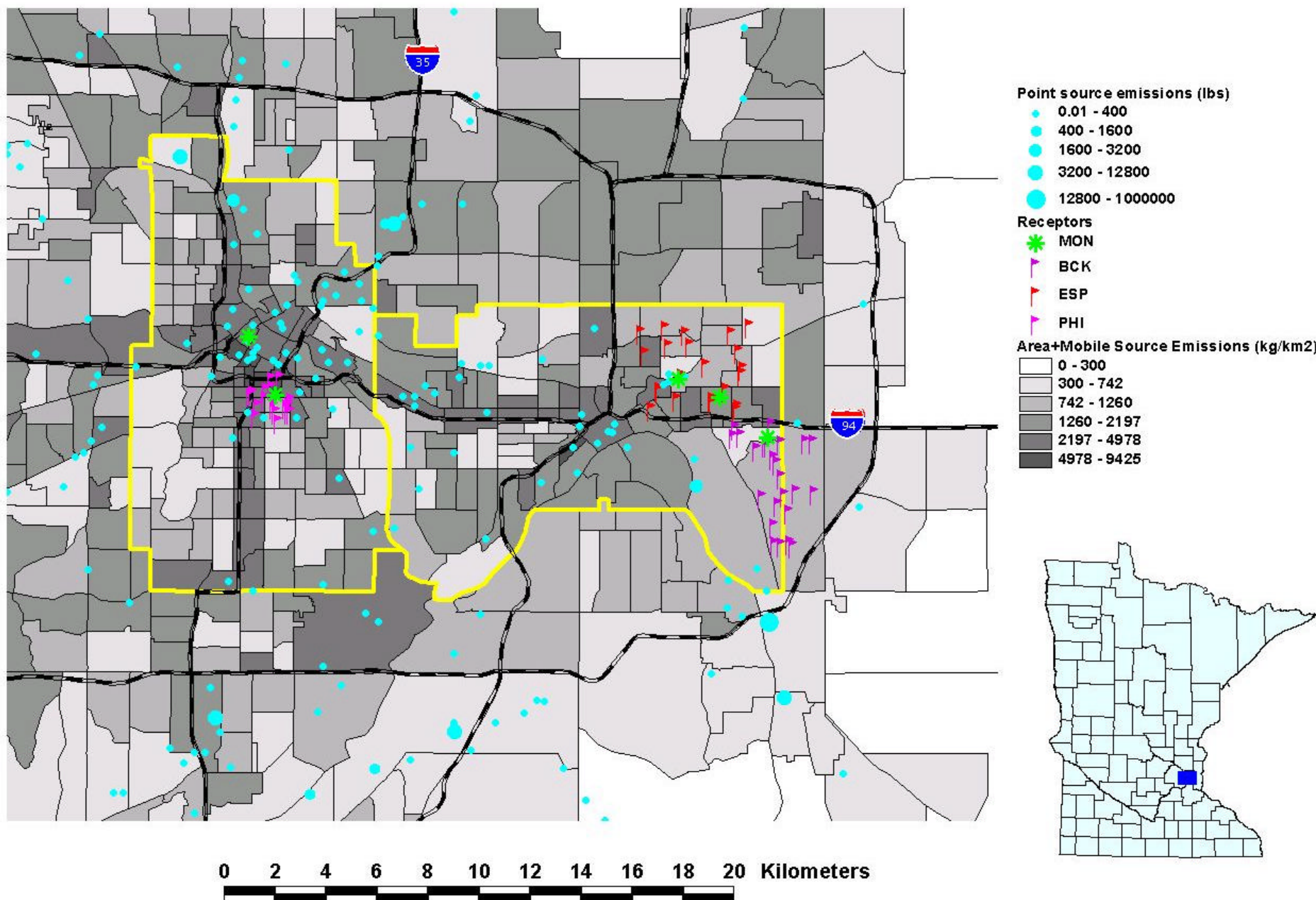
## Area Source Categories - 2

<b>Industrial Surface Coating</b>	<b>Population parsing</b>
<b>Landfills</b>	<b>Assign to Census Tract</b>
<b>Marine Vessel Loading etc.</b>	<b>Not Done (only Duluth)</b>
<b>Prescribed Burning</b>	<b>Not Done (data not available)</b>
<b>Public Owned Treatment Works</b>	<b>Done as Point Sources</b>
<b>Residential Fuel Combustion</b>	<b>Population parsing</b>
<b>Residential Wood Combustion</b>	<b>Population parsing</b>
<b>Solvent Cleaning</b>	<b>Population parsing</b>
<b>Structure Fires</b>	<b>Population parsing</b>
<b>Traffic Markings</b>	<b>Lane Miles</b>
<b>Wild Fires</b>	<b>Area</b>

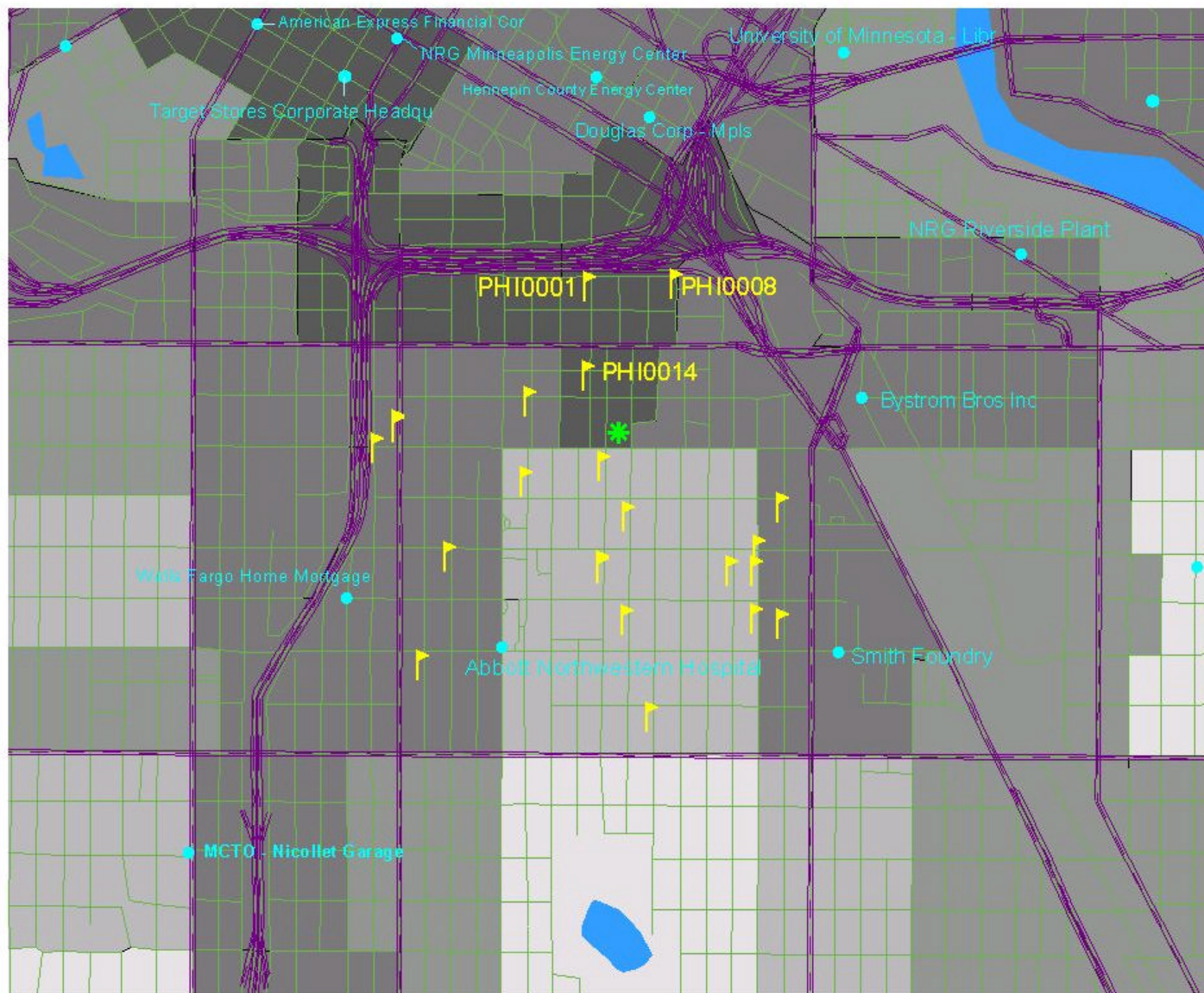
	Point Source Emissions (%)	Mobile Source Emissions (%)	Area Source Emissions (%)
BENZENE	0.5%	88.0%	11.5%
1,3-BUTADIENE	1.1%	89.3%	9.6%
CHLOROFORM	3.7%	0.0%	96.3%
ETHYLBENZENE	3.7%	93.6%	2.7%
MeCl	38.9%	0.0%	61.1%
PERC	17.7%	0.0%	82.3%
STYRENE	20.1%	78.6%	1.3%
TOLUENE	3.1%	60.1%	36.7%
TCE	63.5%	0.0%	36.5%
XYLENES	4.7%	62.7%	32.6% <sub>15</sub>



# Benzene Emissions



# Benzene Emissions



## Point source emissions (lbs)

- 0.01 - 10
- 10 - 50
- 50 - 100
- 100 - 500
- 500 - 2500

## Receptors

- MON
- BCK
- ESP
- PHI

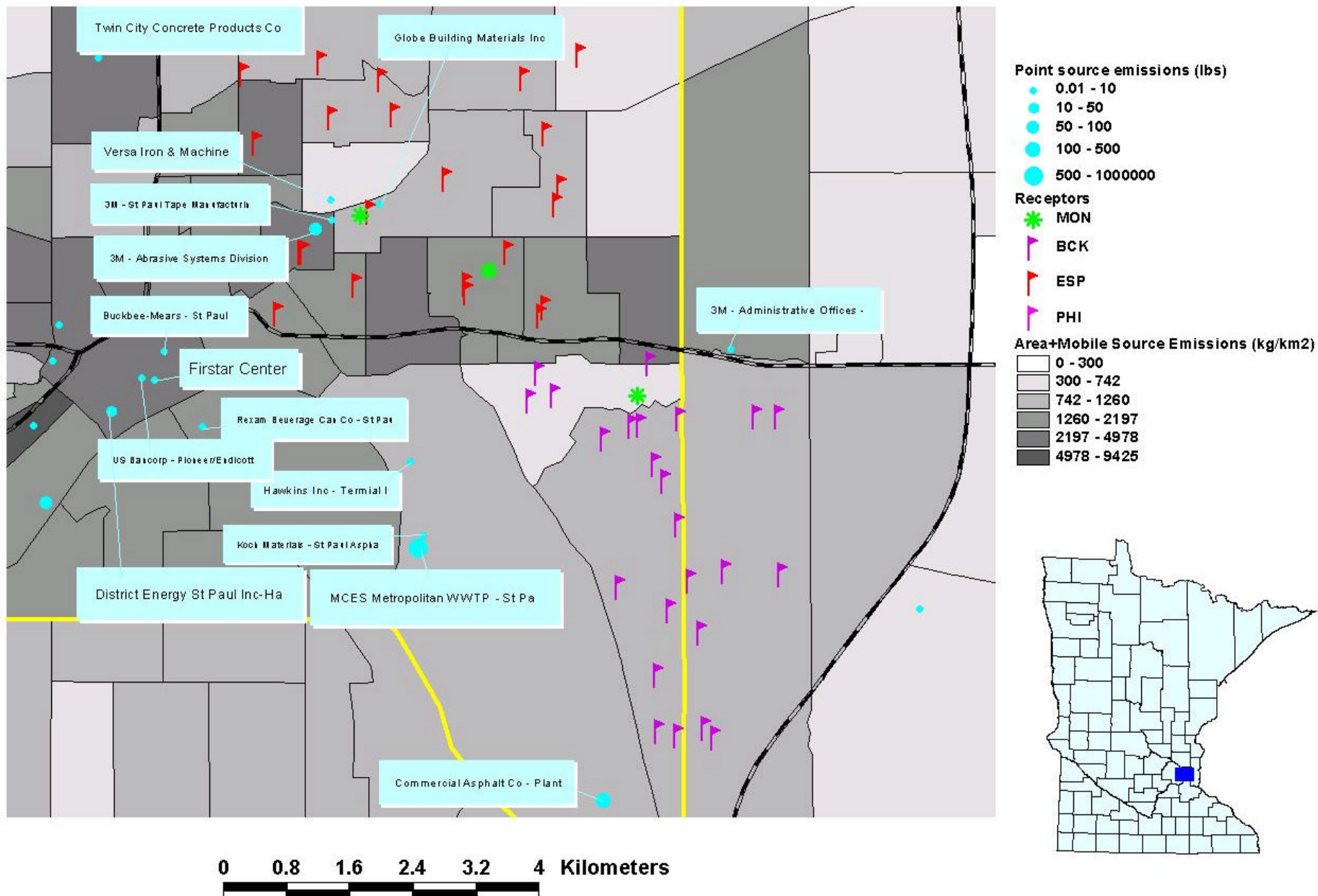
## Area+Mobile Source Emissions (kg/km2)

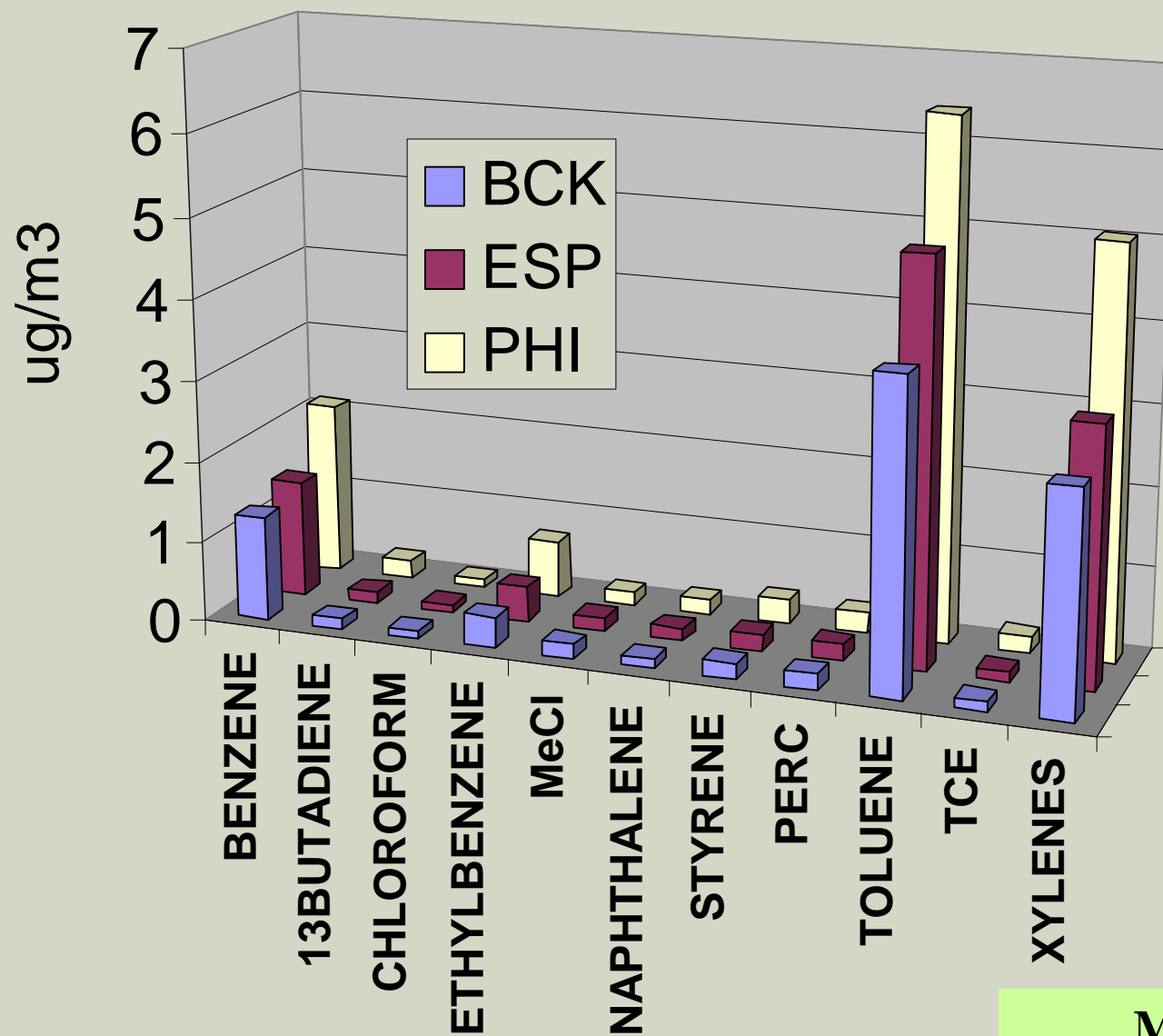
- 0 - 300
- 300 - 742
- 742 - 1260
- 1260 - 2197
- 2197 - 4978
- 4978 - 9425





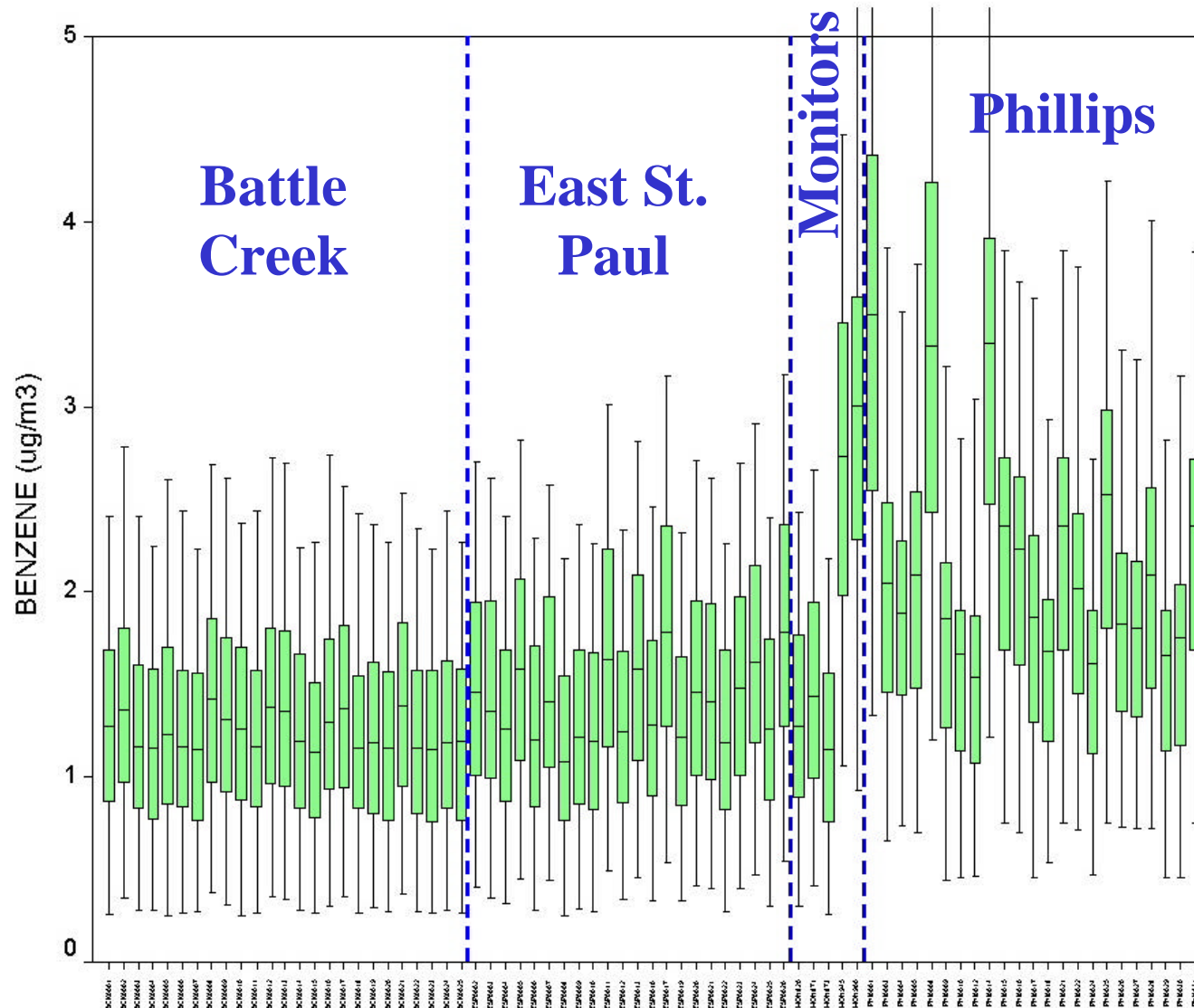
# Benzene Emissions

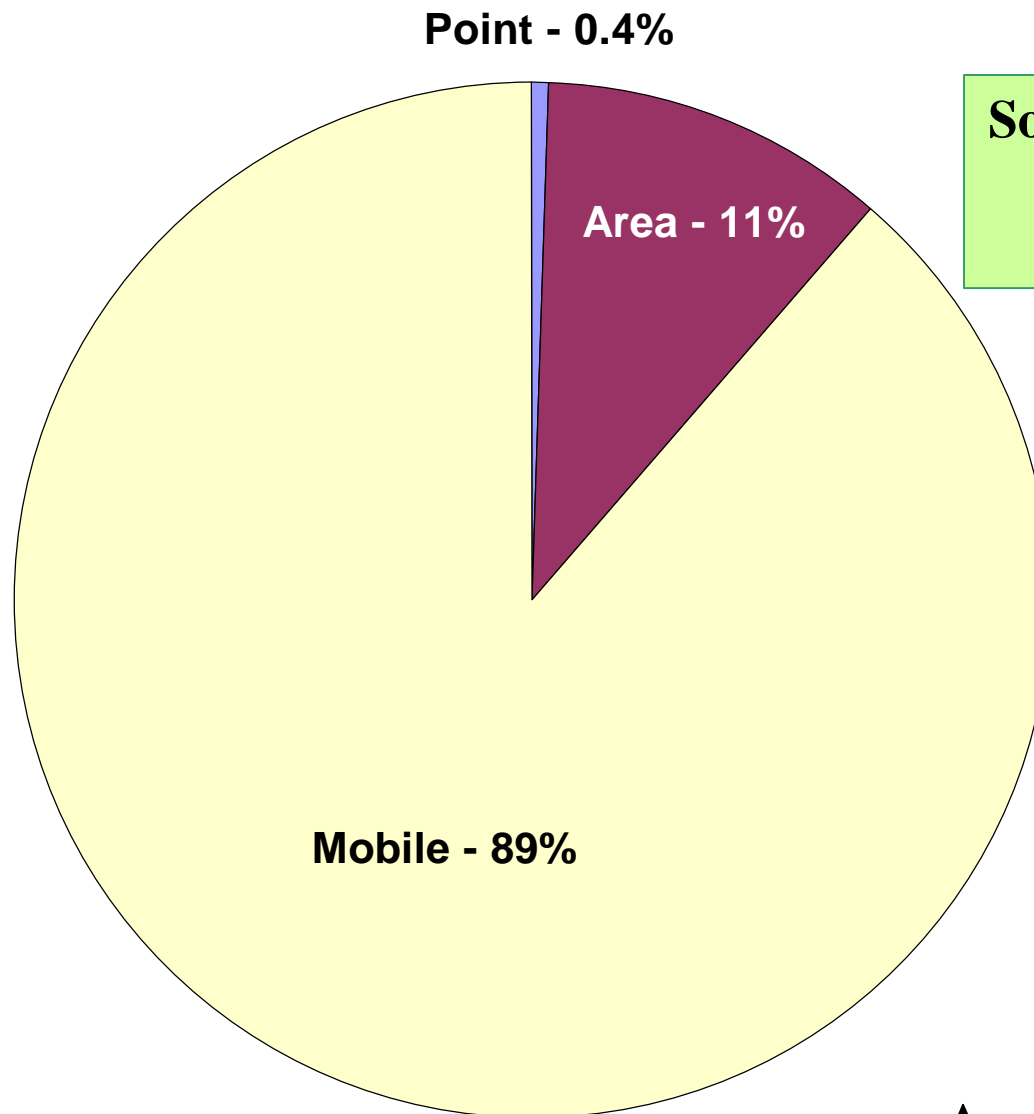




**Modeled  
Concentrations**

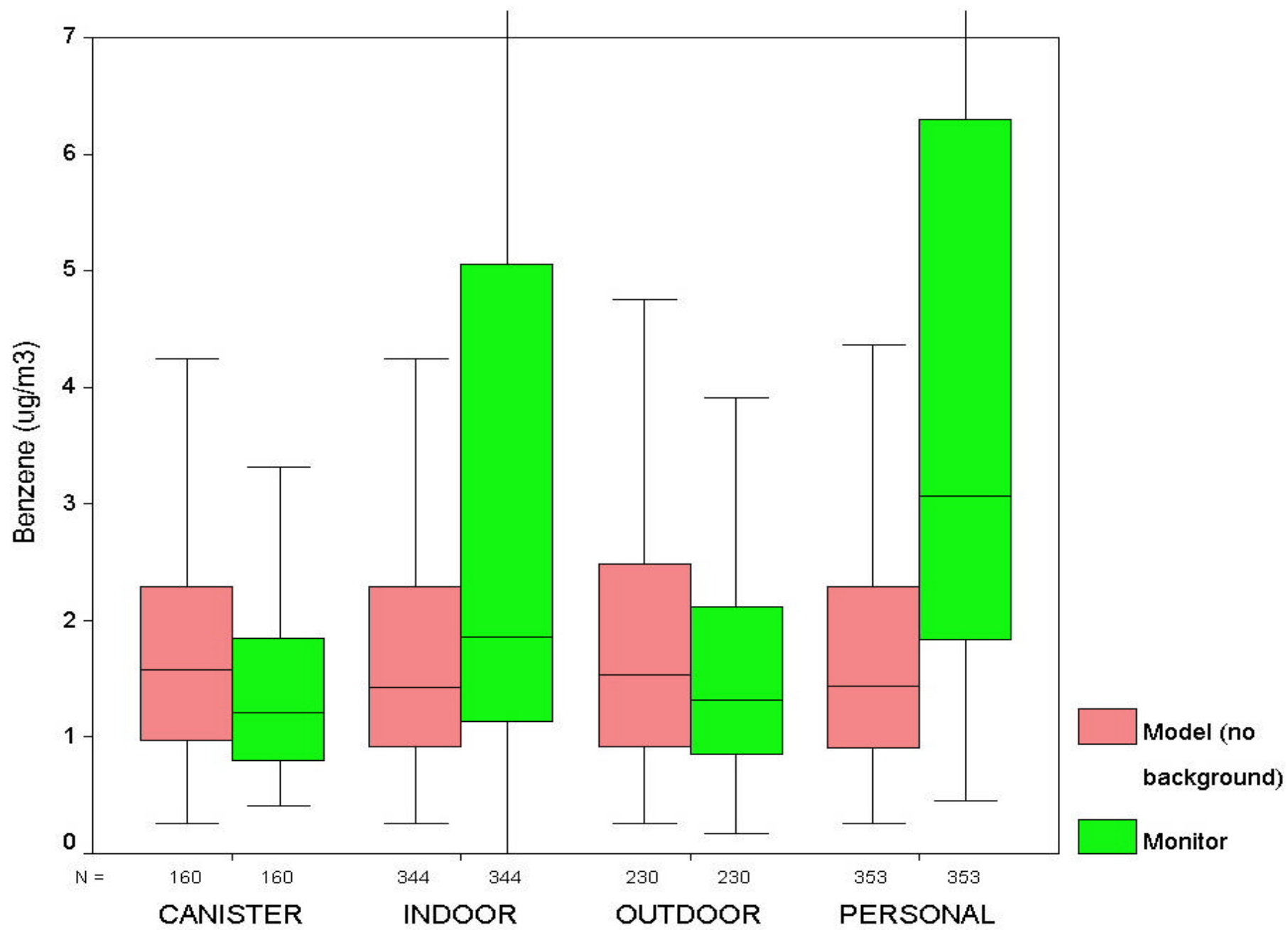
# Benzene Modeling Results



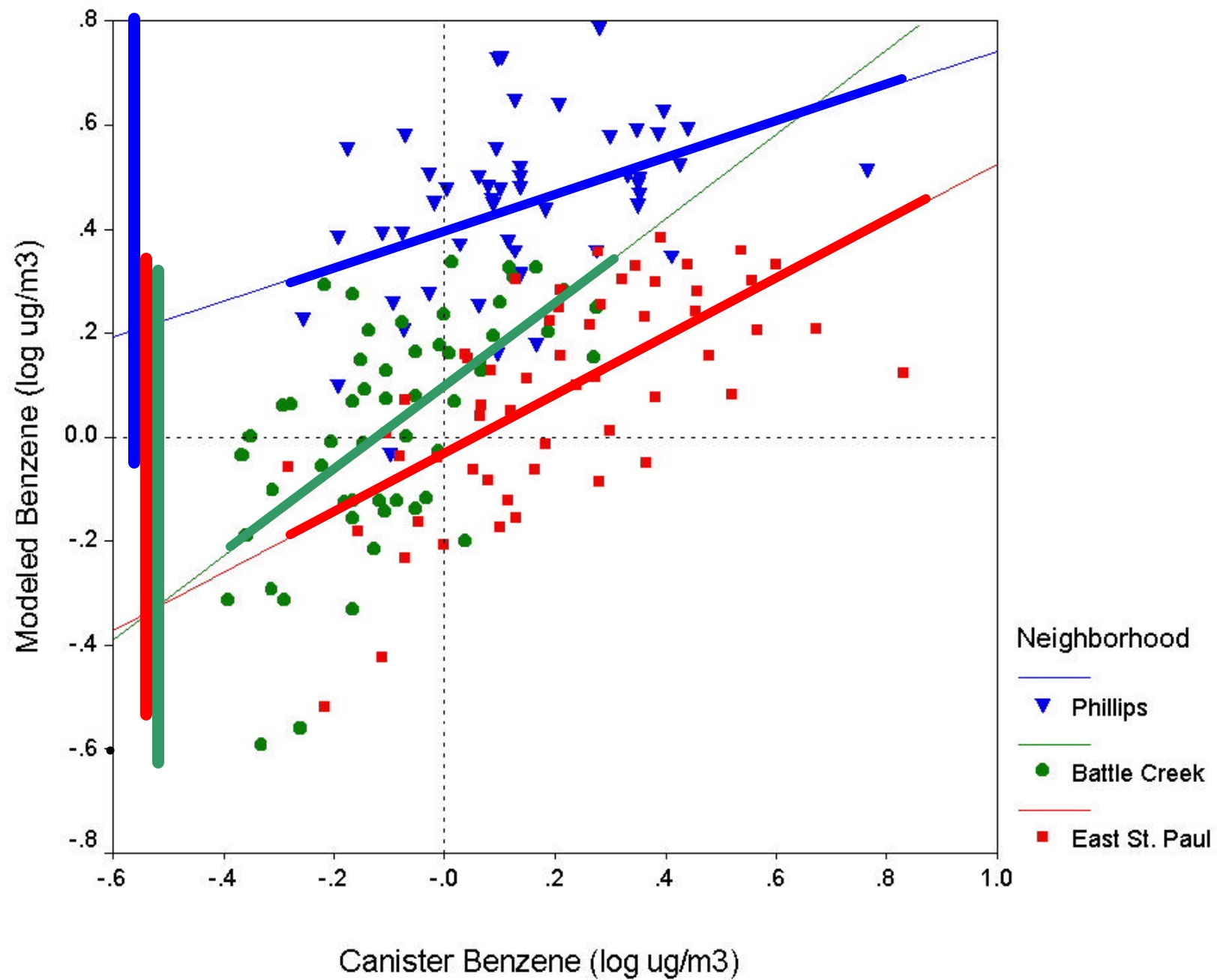


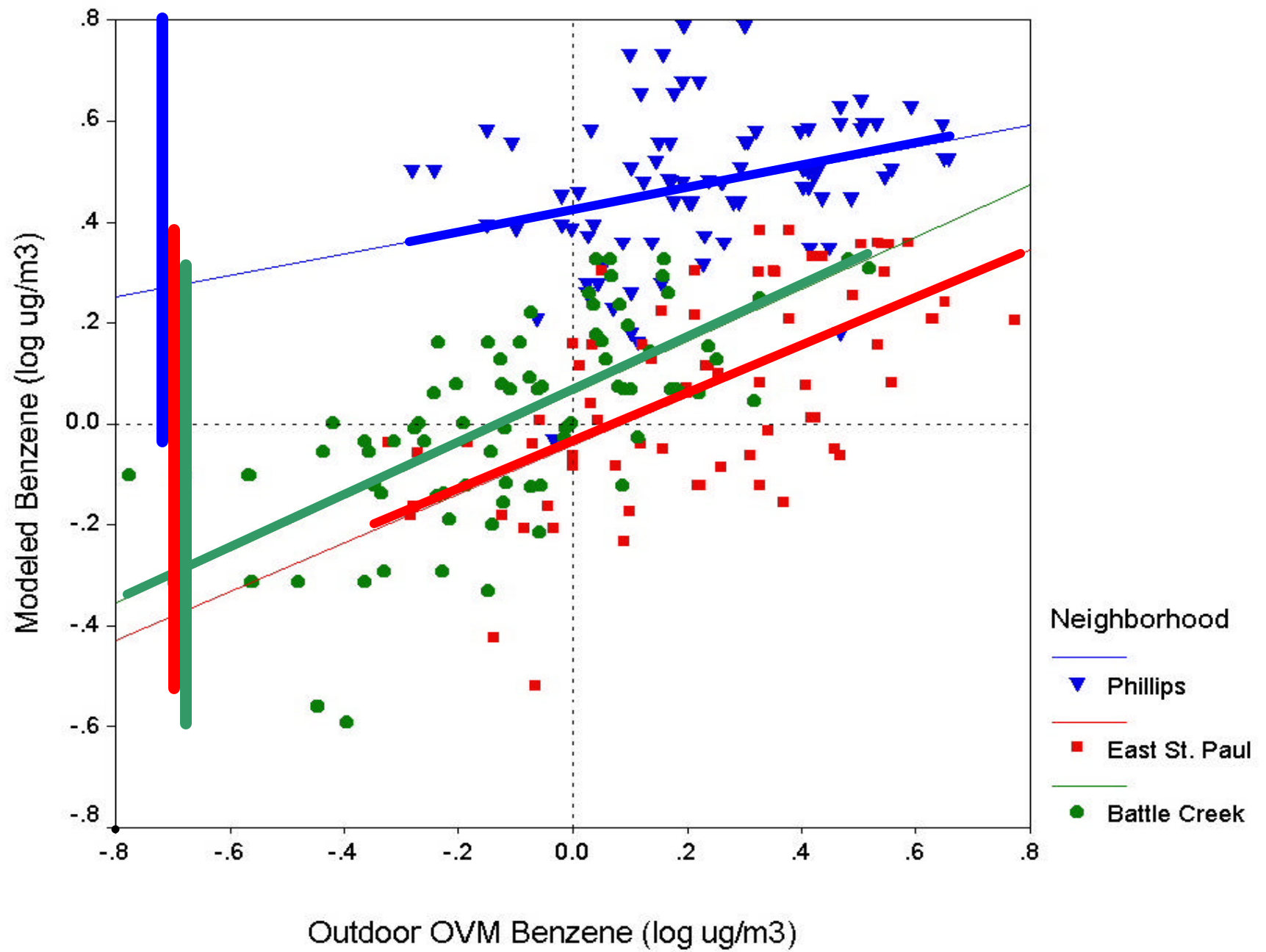
**Sources of Modeled  
Benzene  
Concentrations**

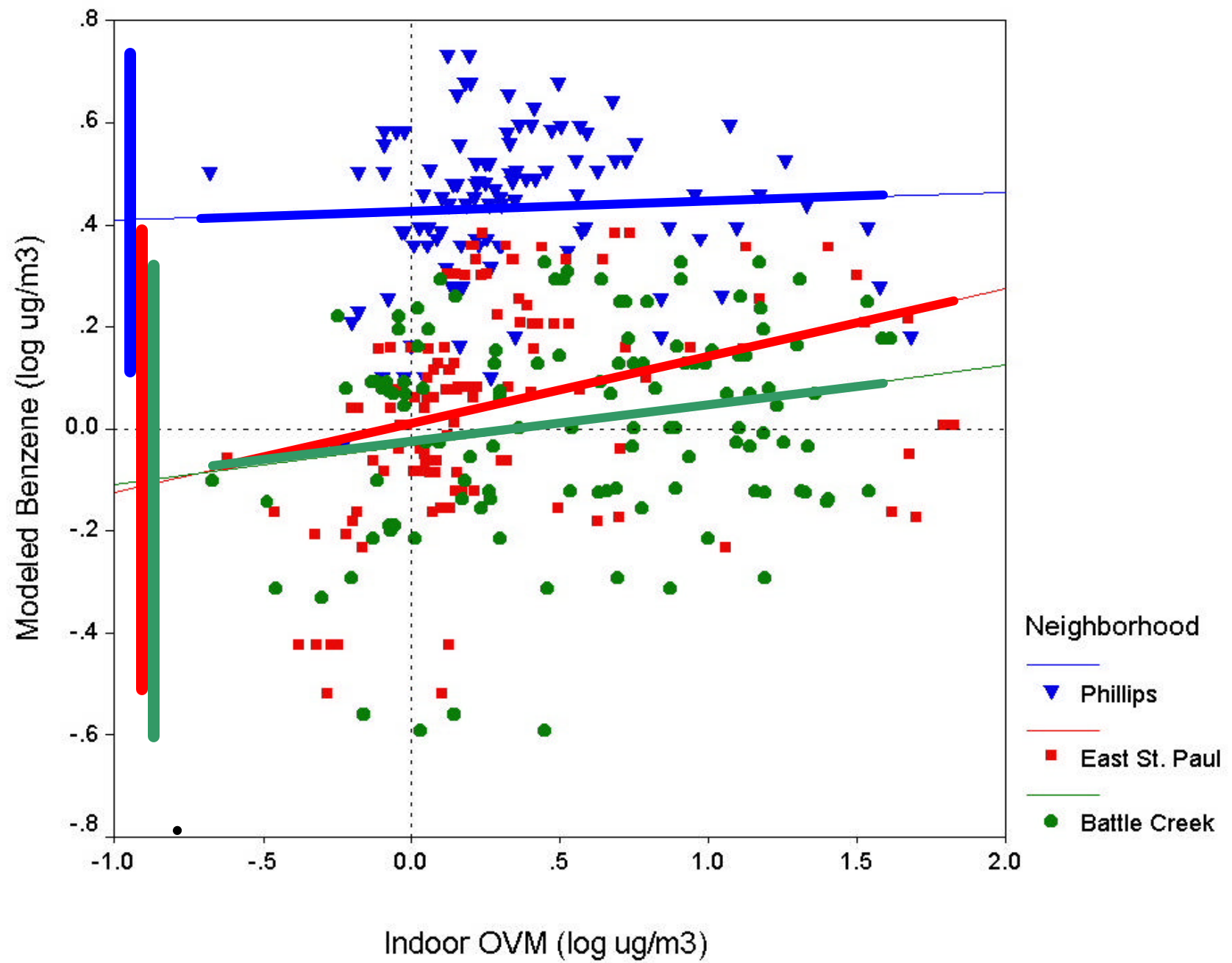
**Averaged over all 75  
receptors and all 58 48-hour  
sampling periods<sup>21</sup>**

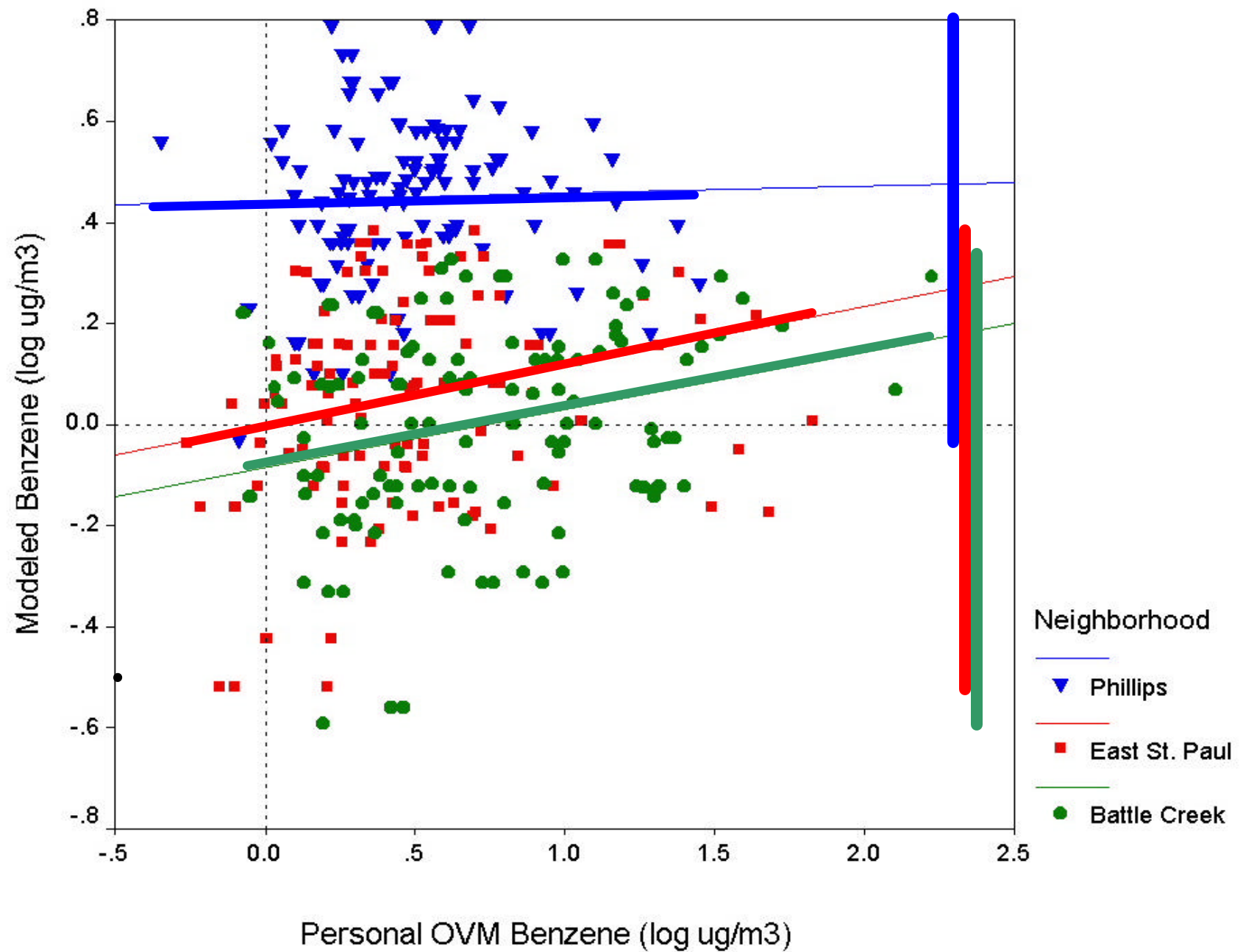












## Regressions (Adj R<sup>2</sup>) between Modeled and Monitored Conc.

Pollutant	Canisters			& Outdoor OVMs			Indoor OVMs			Personal OVMs		
	BCK	ESP	PHI	BCK	ESP	PHI	BCK	ESP	PHI	BCK	ESP	PHI
Benzene	0.38	0.43	0.16	0.44	0.37	0.08	0.04	0.09	-0.01	0.06	0.05	-0.01
Carbon Tetrachloride	-0.02	-0.01	-0.01	0.01	-0.01	-0.01	0.00	-0.01	0.01	-0.01	0.00	-0.01
Chloroform	-0.03	0.02	0.36	-0.03	-0.01	-0.02	-0.01	-0.01	0.00	0.03	-0.01	-0.01
Ethylbenzene	0.32	0.40	0.17	0.42	0.32	0.04	0.01	0.03	-0.01	0.08	0.02	-0.01
MeCL	-0.02	0.03	0.19	-0.01	-0.02	0.04	0.01	-0.01	0.02	-0.01	-0.01	0.00
Styrene	-0.02	0.13	0.12	0.01	0.12	-0.02	0.04	-0.01	-0.01	0.03	0.00	-0.01
PERC	n/a	n/a	n/a	-0.01	0.14	0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Toluene	0.50	0.46	0.19	-0.02	0.08	-0.01	0.00	0.00	-0.01	0.07	-0.01	0.02
TCE	-0.02	-0.02	0.00	0.08	0.00	0.00	-0.01	0.00	-0.01	-0.01	0.00	0.00
Xylenes	0.36	0.39	0.19	0.51	0.34	0.09	0.01	0.05	-0.01	0.07	0.02	-0.01
		p less than or equal to 0.05 and R <sup>2</sup> > 0.1										
		p less than or equal to 0.001 and R <sup>2</sup> > 0.2										

# Conclusions

- **Generally for measured VOCs:  
Personal > Indoor > Outdoor**
- **The ISC model reasonably predicts outdoor VOC concentrations in 2 of 3 communities, likely because the emission inventory is more accurate and/or the area sources less complex**

## Conclusions (Con.)

- **In Phillips, where sources are more complex and mobile source dominated, the ISC model is less accurate**
- **The model appears to over predict low concentrations and under predict high concentrations**
- **The model fails to predict high VOC concentrations found in indoor and personal air**



# Acknowledgements

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- **HAPS study participants in the Phillips, East St. Paul, and Battle Creek Communities**
- **Study staff: Nick Hill, Avuna Sreenath, Tina Ojala, Patty Skogrand and the HAPS field team**
- **Data base management: Mark Bollenbeck and Allen Broderius.**